The role of mulching with residues of two medicinal plants on weed diversity in maize

ILIANA KAMARIARI[1], PANAGIOTA PAPASTYLIANOU[1], DIMITRIOS BILALIS[1], ILIAS S. TRAVLOS[1], IOANNA KAKABOUKI[2]

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Abstract

The effects of mulch with the residues of two aromatic and medicinal plants (Sideritis scardica Griseb and Echinacea purpurea) were evaluated on weed flora and first growth of a maize crop. A field experiment was conducted under organic conditions, while a pot experiment was also conducted at Agricultural University of Athens. Our results showed that there was a significant effect of plant residues on weed flora. The incorporation of Sideritis sp. residues resulted to a lower number of different weed species (low richness) and adequate weed control. During the early growth stages of maize there was a satisfactory control of the broadleaf weeds after the incorporation of S. scardica, resulting to a significantly lower biomass. However, this effect progressively disappeared, with E. purpurea mulch progressively showing a higher phytotoxic activity. The pot experiment revealed that there was not any negative effect of mulching on maize seed germination, emergence and early growth.

Introduction

Lately, medicinal and aromatic plants cultivation has been spreading across Mediterranean countries. Among them, mountain tea (*Sideritis scardica* Griseb.) is a widely known species, while other plants such as eastern purple coneflower (*Echinacea purpurea* L.) are lately extensively studied (Laasonen et al. 2002). Towards a more environment friendly and low input agriculture, several cultural practices have been proposed. Mulching or incorporation of plant residues can reduce the amount of water needed for the main crop, provide valuable nutrients back into the soil and control some weeds (Buhler et al. 1996, Teasdale 1996). The objective of the present study was to evaluate the effects of the mulch of two important medicinal plants (*S. scardica* and *E. purpurea*) on weed flora and maize response at the first growth stages.

Material and methods

One field and one pot experiment were conducted in the experimental field of Agricultural University of Athens (37^{o} 59′01.83″ N, 23^{o} 42′07.37″ E). The soil was a clay loam, whose physicochemical characteristics (0- to 15-cm depth increment) were clay 35.2 %, silt 45.7 %, sand 19.1 %, pH (1:2 H_2O) 7.36, $CaCO_3$ 12 g kg^{-1} and organic matter content of 24.4 g kg^{-1}. Sowing of maize occurred after mulch incorporation in some of the plots. The experiment was conducted under organic management and arranged in a randomized complete block design with three replicates and three treatments: a) incorporation of *S. scardica* residues (5.41 kg per plot), b) incorporation of *E. purpurea* residues (5.28 kg per plot) and c) untreated (without any incorporation). The residues of both medicinal plants came from organically cultivated crops in Greece (provided by KORRES S.A. Co.). Plot size was 4.3 by 5 m. Irrigation and other common cultural practices were conducted as needed during the growing season, while the residues of the medicinal plant came from organically cultivated plants in Greece. The number and dry weight of the dominant weeds were assessed. A wooden square quadrat (40 × 40 cm) was placed at random three times in each plot. Weeds in the 40 × 40 cm area were counted for each species present, and fresh and dry biomass was determined. Five weed assessments regarding the density and the biomass were made at 51, 63, 77, 94 and 117 days after sowing (DAS). The species diversity of weeds was characterized using the Shannon-Weiner index (H) (Booth *et* al. 2003), while Simpson index was also used. For calculation of these indices, the software Bio DAP was used.

A pot experiment was also conducted near the experimental field at Agricultural University of Athens. The experiment was also arranged in a randomized complete block design with eight replicates (pots of 15 L) for each of the three treatments (as in the field experiment). Measurements on seed germination and seedling emergence of maize were taken, while plant height was also recorded. Statistical analysis of the results was performed using one-way ANOVA, while mean comparison was performed using Fisher's least signification different (LSD) test at $P < 0.05$ by means of Statsoft package (1996).

[1]Laboratory of Agronomy, Faculty of Crop Science, Agricultural University of Athens, 75 Iera Odos str., GR 11855, Athens, Greece, www.aua.gr, bilalis@aua.gr
[2]Department of Business Administration of Food and Agricultural Enterprises, University of Patras

Results

In Table 1, the fresh weights of the broadleaf and grass weeds for each treatment are shown. It has to be noted that at the very early stages (1st assessment) there was a very satisfactory control of the broadleaf weeds after the incorporation of *S. scardica*, resulting to a significantly lower biomass. However, this effect progressively disappeared, while it seems that at 77 DAS *E. purpurea* mulch had a significant effect on the several broadleaf weeds (Table 1). A similar trend was also observed for grass weeds.

Table 1. Total fresh matter of broadleaf and grass weeds sampled in the field experiment (S: *S. scardica* mulch, E: *E. purpurea* mulch and U: untreated). Different letters in each row denote significant differences (LSD test, P < 0.05) within each sampling date.

Assessment	**Broadleaf weeds**		
	S	E	U
1st	531.84 b	706.4 a	628.4 ab
3rd	3292.24 a	937.28 b	3627.24 a
	Grass weeds		
	S	E	U
2nd	68.8 b	102.4 a	110.32 a
5th	206.6 a	52 c	131.72 b

Concerning the values of the Shannon-Weiner (H) index, in some cases there were significant differences between the treatments as shown in Table 2. The highest values were recorded in plots with *S. scardica* incorporation, whereas weed flora had high species evenness. According to Booth et al. (2003) this index is increased because of emergence of additional unique species and that was the case in our experiment, with late emergence of many broadleaf weeds (as shown in Table 1). Moreover, it has to be noted the progressively reducing trend during the experimental period for Shannon-Weiner index in the plots of *S. scardica* and *E. purpurea*, providing evidence for a reducing richness. This can be attributed to the fact that the mulches progressively controlled and eliminated several weed species, however specific weeds such as were rather favoured and finally dominated (resulting to a slightly rising high Simpson index).

Table 2. Shannon-Weiner and Simpson indices for the weed community in the field experiment (S: *S. scardica* mulch, E: *E. purpurea* mulch and U: untreated). Different letters in each row denote significant differences (LSD test, P < 0.05) within each sampling date.

Assessment	**Shannon-Weiner index**				**Simpson index**		
	S	**E**	**U**		**S**	**E**	**U**
1st	1.83 a	1.36 b	1.72 a		0.18 a	0.25 a	0.26 a
2nd	1.67 b	1.68 b	1.99 a		0.94 a	0.23 b	0.15 b
3rd	1.60 a	1.09 b	1.55 a		0.22 b	0.45 a	0.20 b
4th	1.66 a	0.82 c	1.07 b		0.19 b	0.47 a	0.37 a
5th	1.43 a	1.05 b	0.89 b		0.26 b	0.35 ab	0.47 a

The results of our pot experiments revealed that the mulch incorporation of *S. scardica* or *E. purpurea* residues in the soil did not cause any negative impact on seed germination and seedling emergence of maize. Moreover, the first growth of maize plants was not significantly different from that of the control, while in some cases and after *S. scardica* or *E. purpurea* incorporation sunflower plants were slightly higher than the untreated ones, probably because of a potential enhancing effect of the residues.

Discussion

The results of the present study showed that *S. scardica* and *E. purpurea* mulch had a clear phytotoxic activity against several common and noxious weed species. Previous studies have shown that *Sideritis* and *Echinacea* species contain several allelochemicals with various effects (Rios et al. 1992, Viles and Reese 1995) and this noteworthy phytotoxic action shown by our studies can be plausibly attributed to the some of these allelochemicals.At a field level, mountain tea residues seem adequate for an effective weed control at early maize stages, while coneflower's mulch provides a long-term weed management. Moreover, the absence of negative effects on maize is clearly desirable and need to be further evaluated in a wider range of crops, soils and climatic conditions. Organic agriculture needs to be relied on environmentally friendly and effective methods of weed control, and under than concept the indicated allelopathic activity of plants like *S. scardica* and *E. purpurea* should be exploited and accomplished with future studies.

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